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to throw some light upon the origin of the coal-beds, which some geologists believe to have been formed from the submersion of forests and the floating of uprooted timber into estuaries and lakes, while others contend that they have been produced by the submersion of beds of peat. Irrespective therefore of other considerations, the author urges in favour of the latter opinion, that wood is not capable of furnishing the amount of nitrogen we find existing in coal, while peat contains rather more than double the quantity required. The expectation of procuring aniline, picoline, &c., the coal series of bases, from the distillation of peat, was disappointed; a result only to be accounted for on the hypothesis, that the different genera of plants, when destructively distilled, yield different series of organic bases.

From the facts which have previously been stated, the author considers himself warranted in concluding, that when ammonia is produced by the destructive distillation of either animal or vegetable substances, it is always accompanied with the formation of organic bases. Now as ammonia is known to be procurable from these substances by other methods than destructive distillation, it seemed highly probable that on these occasions organic bases would also be produced. Beans, oil-cake and flesh, were therefore successively boiled in a distilling apparatus with strong alkaline lyes. In every instance, in addition to ammonia, a series of organic bases was also produced. Similar results were also obtained when the above-mentioned substances were digested in strong sulphuric acid, the acid solution supersaturated with an alkali and subjected to distillation. The ammoniacal liquor which passed into the receiver was found invariably to contain organic bases.

Bases by putrefaction.—As putrefaction is almost the only other means by which ammonia is readily procurable in quantity from vegetable and animal substances, the effects of this process were also examined in the first instance in the case of guano. An aqueous solution of Peruvian guano was saturated with carbonate of soda and distilled. In addition to much ammonia, a quantity of basic oils was also obtained. Subsequent to this experiment, the effects of putrefaction on a quantity of horse-flesh were also examined, when a considerable amount of oily bases was found to have been generated.

From the facts which have now been enumerated, the author concludes "*that whenever ammonia is generated in large quantity from complex animal or vegetable substances, it is invariably accompanied by the formation of a larger or a smaller amount of volatile organic bases.*" If therefore researches similar to the present are actively prosecuted, and if the seeds and leaves of the various genera of plants are subjected to these or analogous processes, it seems not unreasonable to expect that the number of the organic alkaloids will ere long be considerably increased.

6. "On the Development and Varieties of the great anterior veins in Man and Mammalia." By John Marshall, Esq. Communicated by Professor Sharpey, F.R.S.

The object of this paper is to state the result of observations on

the metamorphosis of the great anterior veins in Man and Mammalia, and on the relations existing between the primitive and final condition of these vessels, in different cases, both in their normal arrangement in animals, and their abnormal condition in the human subject.

From an examination of the form and structure of the sinus of the great coronary vein, and of the arrangement of its branches and valves in Man and some of the Mammalia, and from a comparison of those parts with the terminations of the great coronary and other posterior cardiac veins in the other Mammalia, the *coronary sinus* in Man and one set of Mammals, as the Dog, Cat, and Seal, is shown to be *analogous to the lower part of the left vena cava anterior* found in another set, represented by the Elephant, Rabbit and Hedgehog, and to *the lower part of the left vena azygos*, found in a third set, as exemplified in the Sheep, Ox and Pig. The great coronary vein, therefore, is shown always to end in a similar way, viz. in a larger muscular venous channel, which, in all cases, ends in the right auricle of the heart, by a wide orifice situated in an exactly corresponding part of that cavity.

The author remarks that a similar view has recently been published by Bardsleben; but his own observations were completed, and his deductions arrived at, quite independently.

Reflecting on the above-mentioned analogies and on the known method of development of the great anterior veins in *all* the Vertebrata, as pointed out by Rathké, from four primitive lateral venous trunks, viz. two anterior or jugular, and two posterior or *cardinal* veins, the coronary sinus is demonstrated to be the lower persistent portion of the left anterior primitive venous trunk, next to the heart. By Rathké, however, the whole of this left primitive trunk, from the neck down to the heart, is supposed to become occluded and then entirely to disappear in Man, and in such animals as are similarly formed in respect to these great veins; but the author finds that not only does its lower part persist in a previous condition as the coronary sinus, but that other remnants or vestiges of this primitive venous channel are to be found throughout life in Man, and in those animals in which the great anterior veins undergo a like metamorphosis.

The inquiry thus opened is then systematically pursued, first, by tracing the details of the metamorphosis of the great anterior veins in the embryos of the Sheep and Guinea Pig, and in the human foetus; secondly, by a comparison of the adult condition of these great veins in the entire class of Mammalia; and thirdly, by an examination of the occasional varieties of the same vessels met with in the human subject.

1. *Of the development of the great anterior veins.*—After describing at length the metamorphosis of these vessels, the author proceeds to give an account of the remnants of the left anterior primitive vein in the adult.

These are indicated by the following parts, traced from the summit of the left thoracic cavity down to the back of the heart. *Out-*

side the pericardium, certain fine bands of fibrous tissue, which descend beneath the pleura, from the trunk of the left superior intercostal vein to the front of the root of the left lung; and inside the pericardium, *a fold of the serous membrane* which passes down from the left pulmonary artery to the subjacent pulmonary vein,—*certain opaque lines or streaks* upon the side and back of the left auricle,—a small *oblique auricular vein* which is continued from those streaks down to the coronary sinus,—and lastly, the *coronary sinus* itself. The fold of the pericardium, which hitherto has escaped observation, is particularly described. It is named by the author the *vestigial fold of the pericardium*, or, from its having contained the canal of Cuvier in the embryo, the *Cuvierian fold*.

2. Under the second head, a *comparison* is instituted between the *great anterior veins of Man and the Mammalia* generally.

Having remarked that, as high up in the vertebrate scale as Birds, no fundamental alteration occurs from the primitive condition of two anterior and two posterior independent lateral venous trunks, the author remarks that in *all* Mammalia one *characteristic* change is met with, viz. the formation of a transverse branch across the root of the neck.

The right anterior primitive vein in all cases persists as the right or ordinary vena cava superior; but the left vein either remains unoccluded, and returns the blood from the left side of the head and neck, from the left upper limb, the left side of the thorax, and from the substance of the heart; or, owing to a partial occlusion, returns only the blood from the left side of the thorax and from the substance of the heart; or, owing to still further occlusion, from the substance of the heart alone. Hence three principal groups arise.

a. In the first group a right and a left superior vena cava exist, connected by a cross branch at the root of the neck, as in the Monotremata, Marsupialia, the Elephant, most Rodentia, the Hedgehog and the Bat.

b. In another group a right superior cava and a left vena azygos exist, as in the Sheep, Goat, Ox, Pig, Horse, Mole and Guinea Pig.

c. In the third group there is found, besides the right vena cava superior, only a left cardiac venous trunk or coronary sinus, together with the vestiges already described, as in the Cetacea, Carnivora and Quadrumana, as well as in Man.

In each of these groups subordinate varieties are shown and classified.

3. *The almost numberless varieties of the great anterior veins in the human subject* are then arranged on principles similar to those adopted in regard to the different conditions found among Mammalia; but the groups are arranged in the inverse order, and the usual condition of the veins in Man is included as a necessary element in the series.

In one large *class* of cases, comprehending *three groups* similar to those of the different Mammalia already defined, the cross branch in the neck is always present.

a. In the first group there is a right vena cava superior, and a left

cardiac venous trunk or coronary sinus. This is the ordinary condition. Further subdivisions arise, depending on peculiarities of the vena cava itself, which are rare; of the azygos system, which are exceedingly numerous; and of the coronary vein and sinus, which are again uncommon. Transposition occasionally produces a further modification, in which the superior cava is found on the left side; whilst the coronary sinus, the oblique vein and the vestigial fold of the pericardium, exist on the right.

b. In another group there might exist a right vena cava superior and a left vena azygos, as in the Sheep; but no example of this possible variety has yet been met with in the human subject.

c. In the third group a right and a left superior cava coexist, as in the Elephant, constituting what is termed a double vena cava superior. Thirty examples of this condition are adduced, of which eleven only have occurred in adult and otherwise perfect hearts. One of these was met with by the author, and is specially described.

Lastly, a separate or second *class* consists of those cases in which the cross branch is wanting, and which are, accordingly, destitute of the characteristic mammalian type, and present, as in Birds, the persistent condition of four independent lateral venous trunks.

The paper is illustrated by original drawings, of the development of the veins in the Sheep and in Man, of the vestiges of the left primitive vein ordinarily found in the adult human subject, and of the fresh example of double vena cava superior in Man met with by the author.

7. "A Mathematical Theory of Magnetism." By William Thomson, M.A., F.R.S.E., Fellow of St. Peter's College, Cambridge, and Professor of Natural Philosophy in the University of Glasgow.

The theory of magnetism was first mathematically treated in a complete form by Poisson. Brief sketches of his theory, with some simplifications, have been given by Green and Murphy in their works on Electricity and Magnetism. In all these writings a hypothesis of two magnetic fluids has been adopted, and strictly adhered to throughout. No physical evidence can be adduced in support of such a hypothesis; but on the contrary, recent discoveries, especially in electro-magnetism, render it extremely improbable. Hence it is of importance that all reasoning with reference to magnetism should be conducted without assuming the existence of those hypothetical fluids.

The writer of the present paper endeavours to show that a complete mathematical theory of magnetism may be established upon the sole foundation of facts generally known, and Coulomb's special experimental researches. The positive parts of this theory agree with those of Poisson's mathematical theory, and consequently the elementary mathematical formulæ coincide with those which have been previously given by Poisson.

The paper at present laid before the Royal Society is restricted to the elements of the mathematical theory, exclusively of those parts in which the phenomena of magnetic induction are considered.